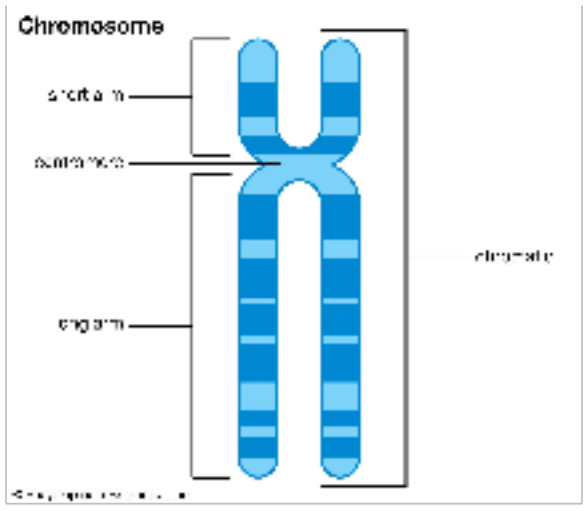
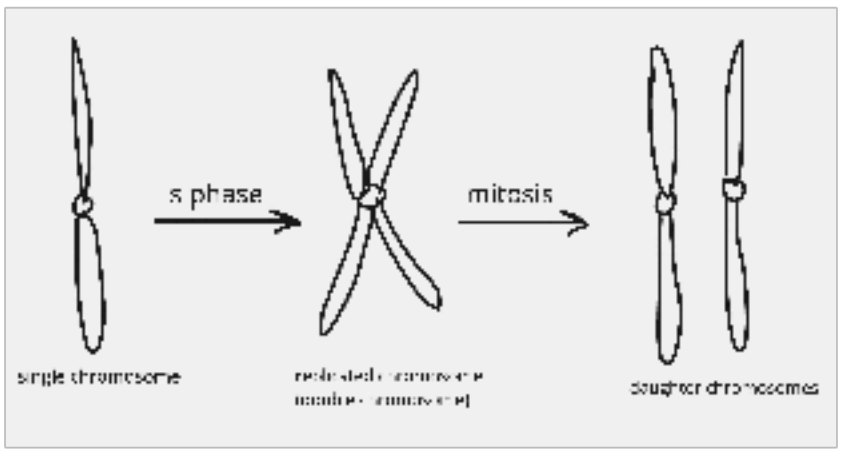
- DNA is temporarily packaged into a *tightly wound and condensed* chromosome prior to division (supercoiling)
- in this condensed form, the DNA is able to easily segregate however it is ***inaccessible for transcription***
- DNA is organised as *chromosomes* during the process of mitosis (condensed in prophase, de-condensed in telophase)



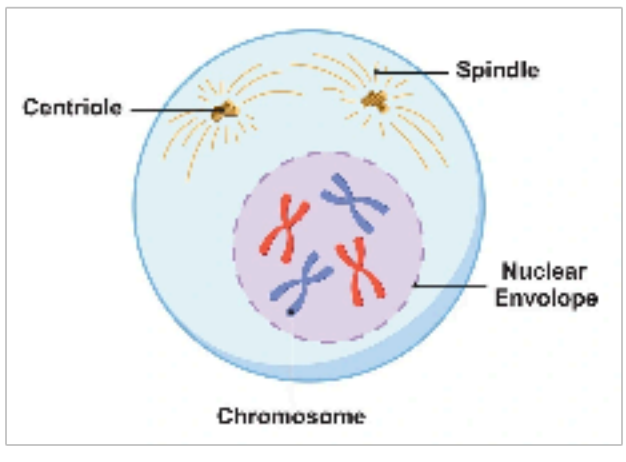


- as DNA is replicated during **s phase** the chromosome will initially contain ***2 identical DNA strands — sister chromatids held by centromere***
- when chromatids separate during mitosis → become independent chromosomes each made of a *single DNA strand*

stages of mitosis

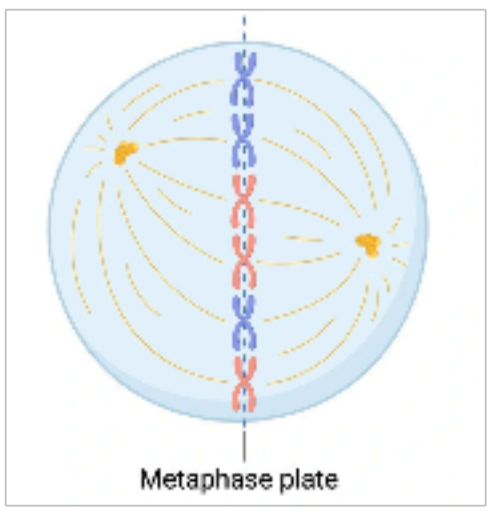
prophase

1. chromatin becomes **shorter, fatter and more tightly coiled** to form the *chromosomes*
    a. supercoiling of chromatin
2. *nucleolus* breaks down
3. *nuclear membrane* breaks down
4. *microtubules grow* from microtubule organising centres
5. microtubules form an array of ***spindles*** that link to the poles of the cell
6. the **centrosomes (centrioles)** move towards the opposite poles, lengthening the microtubules



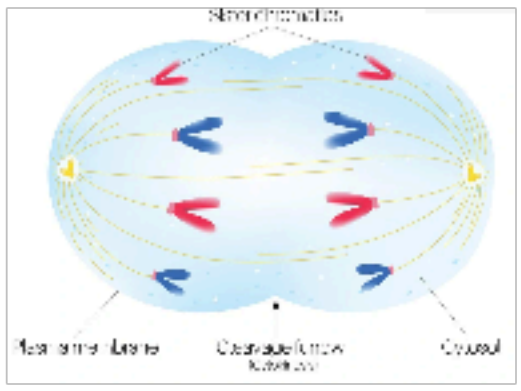
metaphase

1. *microtubules* **grow and attach** to ***kinetochores*** found on the centromere of each chromosome
2. attachment points are on ***opposite sides of the centromere***
3. microtubules are put under tension to ensure correct attachment
    a. by shortening of microtubules at the centromere
4. thick, coiled chromosomes move or line up at the ***middle / equator*** of the cell on the *metaphase plate*
5. spindle fibres are attached to the chromosomes



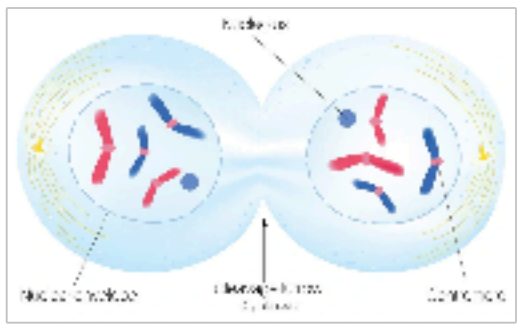
anaphase

1. the ***centromere divides*** allowing sister chromatids to separate
2. spindle microtubules **pull them rapidly towards the poles** of the cell
3. 2 ***genetically identical nuclei*** are formed because **sister chromatids** are pulled to opposite poles ensured by the way spindle microtubules were attached in metaphase



telophase

1. chromatids reached the poles and are now *chromosomes*
2. at each pole chromosomes are pulled into a tight group and a ***nuclear membrane reforms***
3. chromosomes ***uncoil*** to form **chromatin and the nucleolus** is formed
4. the *spindle* apparatus disappears
5. the cell is already beginning to split and *2 daughter cells* enter the interphase



▼ **describe the events that occur during mitosis [9]**

- sequence of stages is prophase → metaphase → anaphase → telophase
- chromosomes condense/supercoil/become shorter and fatter in prophase; spindle microtubules grow (from poles to equator) in prophase/metaphase; nuclear membrane breaks down in prophase/metaphase;
- spindle microtubules attach to the centromeres/chromosomes in metaphase; chromosomes line up at equator in metaphase;
- centromeres divide / (paired) chromatids separate / chromosomes separate into two --------chromatids in metaphase/anaphase;(sister) chromatids/chromosomes pulled to opposite poles in anaphase; spindle microtubules disappear in telophase;
- nuclear membrane reforms around chromosomes/chromatids in telophase;
- chromosomes/chromatids decondense in telophase;

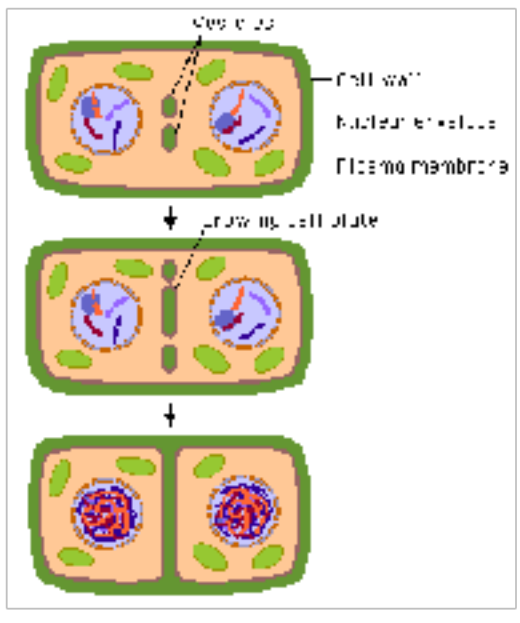
cytokinesis

→ the **division of the cytoplasm** to form 2 cells

it occurs differently in plants and animals

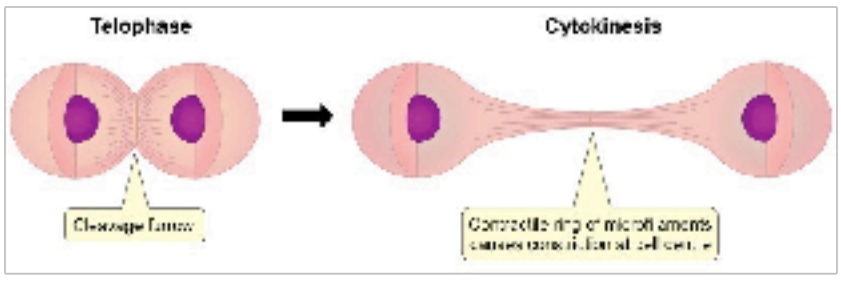
plant cells:

- vesicles (from golgi) are moved to the equator of the cell where they fuse to form *tubular structures* known as **cell plate**
- vesicles continue to *merge forming 2 layers* of membrane across the equator → forms the **plasma membranes** for the 2 daughter cells which connect to the *existing membranes* at the side of the cell, completing the division of the cytoplasm
  - ***pectins*** and other substances are brought by *vesicles* and deposited in the new membranes by *exocytosis* forming the *middle lamella* that will link the cell walls
  - ***cellulose is deposited by exocytosis*** adjacent to the lamella
  - a new ***cell wall*** is formed across the equator of the cell with plasma membrane on both sides

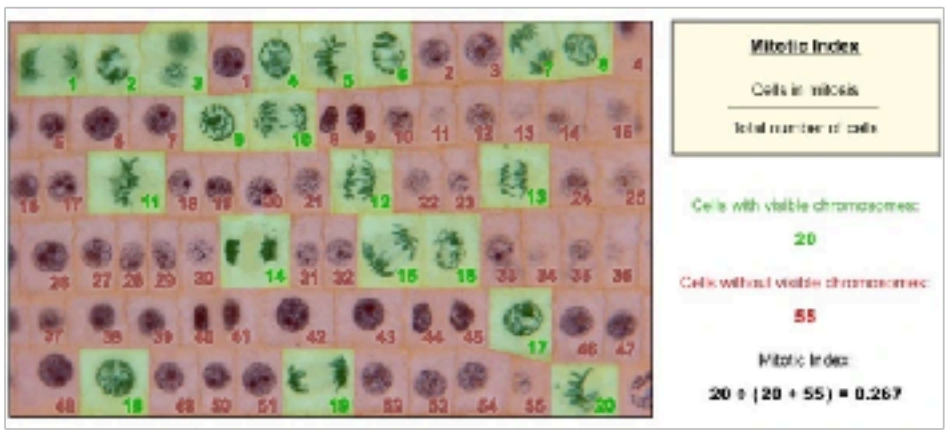


animal cells:

- the plasma membrane at the equator is *pulled inwards* forming a **cleavage furrow**
- this is done using ***contractile proteins (actin and myosin)*** in the plasma membrane → rings of protein contract
- when the cleavage reaches the centre, the cell **is pinched apart** forming 2 daughter cells



mitotic index

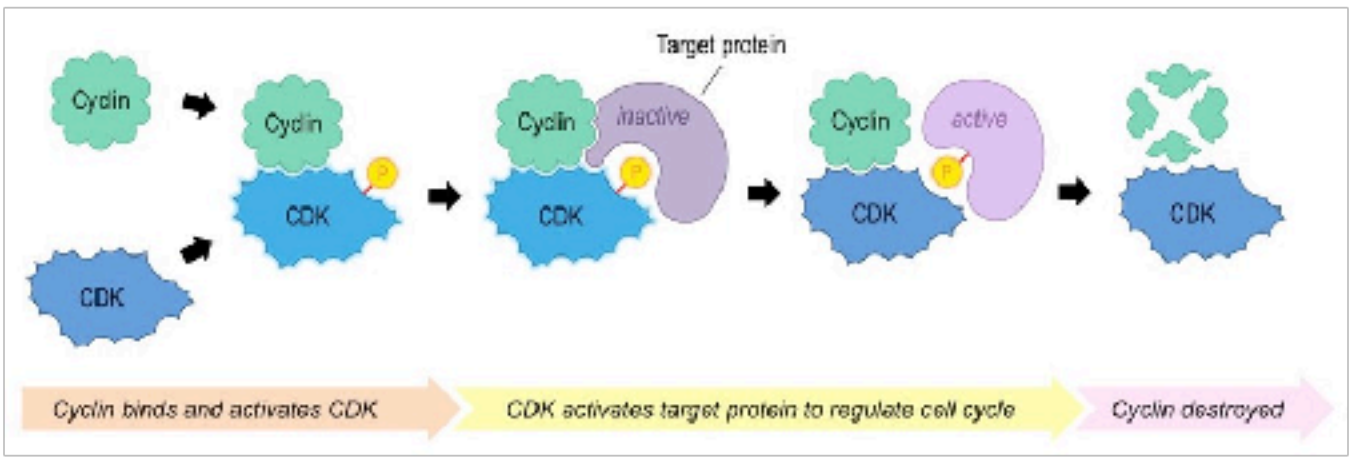


- the index refers to *ration* between the ***number of cells in stages of mitosis*** in a tissue and the ***total number of observed cells*** in the tissue
- formula:

  mitotic index = number of cells in mitosis / total number of cells x100 (for %)
- can be used by doctors to predict how fast a *tumour* will grow → a high index indicates fast growing

cyclins

- a group of *regulatory proteins* that will control the cell's **progression through cell cycle,** to ensure cell tasks are performed at correct time and move to the next cycle when appropriate
- cyclins bind to enzymes — ***cyclin dependant kinases (CDK)***
  - kinases become *active* enabling the cell to move from between each phase → points of function are called **checkpoints**
  - these enzymes attach **phosphate groups** to other proteins in the cell → triggers these other proteins to become active and carry out tasks specific to 1 of the phases
- after event, the cyclin is ***degraded*** and the CDK is inactive again



4 types of cyclins